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TABLES

Where information regarding treatment, management, and disposal of the radioactive source, byproduct material and/or special nuclear components of mixed waste (as defined by the Atomic Energy Act of 1954, as amended) has been incorporated into this document, it is not incorporated for the purpose of regulating the radiation hazards of such components under the authority of chapter 70.105 RCW and its implementing regulations but is provided for information purposes only.

4.0 BULK VITRIFICATION TEST AND DEMONSTRATION FACILITY

The DBVS treatment equipment will be installed and operated under two phases as described in Section 1.7.1. The scope and conduct of the phased operation is described in detail in Section 5.0. Unless otherwise stated, the configuration and operation described are consistent with Phase 2 activities.

4.1 TECHNOLOGY-SPECIFIC GOALS AND OBJECTIVES

The primary purpose of testing the DBVS is to fully demonstrate the bulk vitrification process on Hanford tank waste while meeting the project objectives listed in Section 1.5 and assuring protection of human health and the environment. In terms of technology-specific assessment goals and objectives, the DBVS must also demonstrate its ability to perform effectively while:

- Preventing the release of contaminants into the environment during processing
- Preventing exposure of plant operating personnel to hazardous process streams
- Minimizing the production of secondary waste streams.

4.2 PROCESS AND EQUIPMENT DESCRIPTION

The primary technology to be used for the DBVS is an ICV® process. Process flow diagrams for both phases of the RD&D project are provided in Appendix B. Process operation is essentially the same for both phases.

The salt solution is retrieved from Tank 241-S-109, subjected to pretreatment as required (Section 1.7.3), and transferred to the waste receipt tank(s). The waste is mixed with glass formers in a mixer/dryer unit and dried prior to being transferred to the ICV® containers (Section 4.2.8). Transfer of the dried waste mixture is accomplished through ports in the container lid.

The ICV® container is prepared before the waste mixture is transferred to the container. Preparation of the ICV® container includes lining the container with refractory materials that will be selected based on successful testing/operation at the range of process temperatures expected. Refractory material will include cast material and sand as noted in Appendix F. The electrodes are then mounted on the container lid. The lid is lowered onto the container with a refractory gasket sealing the lid to the container, bolted in place, and the offgas ductwork is connected. Once the ICV® container is prepared, the waste mixture is added from the mixer/dryer in batches.

The waste mixture is vitrified by resistive heating caused by electrical resistance of soil and waste. The heating cycle lasts for approximately 130 hours.[1] Vitrification emissions are routed to an offgas treatment system (Section 4.2.12).

After completion of the vitrification process (Section 4.2.11), fill material (e.g., sand) will be added to fill the void container volume and provide a sufficient fill fraction (>90% by volume) for container landfill disposal. The vitrified waste will undergo cooling, sampling, and external

[1] Total container processing time, including waste mixing/drying, container fill, connection hookup, etc., is approximately 168 hours or one operating week.

decontamination as required. Final cooling may occur at designated cooling stations along the process line or at an interim storage location on the Test and Demonstration Facility site. Core samples may be removed through ports in the container for analysis and testing. Test results will be used to support waste form qualification, risk assessment, and performance assessment. A composite core sample (e.g., vitrified material, sand, and refractory material) will be evaluated for compliance with LDR, as noted in Section 6.0.

4.2.1 System Capacity

The feed rate to the mixer/dryer may be varied as one of the parameters being evaluated through this demonstration project. During Phase 1, up to three test runs will be performed to conduct systems verification and initial waste treatment using approximately 1,135 L (300 gal) of tank waste per container. The amount of waste introduced into each container will be varied during Phase 2 in order to investigate the effect of waste loading on processing time, electric power usage, etc. Over the entire series of test campaigns in Phase 2, the average waste material volume used per test will be approximately 58,080 L (15,345 gal) of a 5 M salt solution. However, individual campaigns may be conducted using up to 76,540 L (20,220 gal) of a 5 M salt solution in a container load.

4.2.2 Waste Retrieval System

As noted in Section 2.3.2, the WRS will provide waste feed from Tank 241-S-109 to the DBVS in two distinct phases. During Phase 1, a limited quantity of waste is planned to be provided to the DBVS. During this phase, the quantity of waste will be limited within the facility such that the facility will be classified as below a Hazard Category-3 radiological facility as defined in DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. During Phase 2, the quantity of waste to the facility will be increased such that the facility will be classified as a Hazard Category-2 facility. The qualitative definition of a Hazard Category-2 facility is that the hazard analysis shows the potential for only significant localized consequences.

During Phase 1, waste transfer could occur through a Waste Staging Tank Skid, and when this occurs, the following safety features will be included:

- Leak detection - The skid will perform a secondary containment role. If there are any leaks in the staging tank, piping, fittings, etc, within this skid, the skid will contain the leak. A leak detection sensor located on the floor of the skid will detect the leak and activate an alarm system. Any material leaked into the skid will be routed back to either Tank 241-S-109 or to the DST system.
- Waste staging tank ventilation - The waste staging tank and the containment structure will be “passively vented” to atmosphere through high-efficiency particulate air (HEPA) filter(s).
- Tank overflow protection - A tank overflow detector will be provided, with remote indication that the tank level has been exceeded. An overflow line will also be provided to direct the overflowing waste to the floor of the skid. As mentioned above, if this “faulted condition” occurs, the leak detection system will identify the situation and waste transfer operations can be stopped.

- Sampling port - A sampling port will be provided on the top of the waste staging tank to allow waste samples to be withdrawn from the tank for analysis.
- "Bad batch disposal"- If the waste staging tank's contents are found not to be within the acceptable specification for acceptance to the DBVS, the waste batch will be sent to the DST system. The waste retrieval pump can be valved to send out-of-specification waste back into the transfer line to Tank 241-S-109, and via the 3-way valve in the pump pit, to the SY Farm Waste Retrieval Receiver Tank.

4.2.2.1 Phase 1 Activities. During Phase 1, waste from Tank 241-S-109 could be sent to a double-wall staging tank that will hold 3,780 L (1,000 gal) of waste or the waste could be sent directly to the waste receipt system. A retrieval pump will be used to remove waste from Tank 241-S-109 and transfer it either to the staging tank or directly to the waste receipt system. It is anticipated that the waste transfer pump will be a jet pumping system similar to the ones used for saltwell pumping on the Hanford Site and that the transfer rate will be between 19 L/min and 28 L/min (5 - 10 gpm). The pump, solids/liquid separator, and the sensing systems noted in the following paragraphs will be located in a pump pit containment structure adjacent to Tank 241-S-109.

The pump suction will be screened to prevent entrainment of solid particles in the pump inlet stream. The pump discharge will be routed through a solids/liquid hydroclone separator capable of reducing the waste stream solids content to 3% or less. Hydroclone separator devices use a tangential inflow to a vertical cylindrical vessel creating a spiral flow path for the liquid, using centrifugal forces to remove solid particles from the flow stream and move them outwards to the vessel walls. The dispersed particles move downward under gravity into a cone-shaped collection chamber, while the purified liquid moves upward to the center of the unit to a top mounted outlet. The unit is usually equipped with an airlock on the collection chamber to maintain pressure drop across the unit without drawing in ambient air. This filtration system will have the capability to be flushed back to Tank 241-S-109 and/or be replaced, if the differential pressure across it exceeds the allowable value.

From the solids/liquid hydroclone separator, the filtered waste will be monitored by sensing instruments to provide process control over waste transfer or waste characteristic information. Waste transfer process control will be based on the results of waste sampling and analysis. The proposed instruments to be included in this system are:

- A flow meter capable of indicating the specific gravity and flow rate of the waste.
- A chemical speciation probe.[1] This is an experimental device being developed by Pacific Northwest National Laboratory that will utilize Raman technology to provide scientific information on the chemical speciation of the waste.
- A conductivity probe. This device will provide information on the waste conductivity. The conductivity probe is planned to be a process control device.
- An optional gamma radiation monitor.

[1] Due to the experimental nature of this probe, it will not be used for regulatory compliance purposes.

A three-way valve will direct waste to either the waste staging tank, waste receipt system or, if the waste does not meet the waste acceptance criteria noted in Section 6.0, to the DST system for storage and eventual disposal. The waste transfer piping from pump pit to any of these locations will be through a hose-in-hose-transfer line (HIHTL) and will be equipped with an optional on-line radiation monitoring system which will continuously measure the quantity of Cs-137 being transferred through the HIHTL.

Initial waste retrieval during Phase 1 will direct waste to the DST system. CH2M HILL Process Engineering personnel will monitor the transfer data, while waste is being sent to the SY tank farm and determine when to route the waste stream to the waste staging tank or the waste receipt system. When the waste characteristics are deemed acceptable for processing, the three-way valve in the pump pit will be positioned to send waste to the waste staging tank or the waste receipt system.

When used, the waste staging tank will have only one inlet/outlet combination. While transferring waste from Tank 241-S-109 to the waste staging tank, the tank will be connected to Tank 241-S-109 via a HIHTL. With this design, the system is physically disconnected from the DBVS facility when the waste staging tank is being filled with waste. Once the waste staging tank is filled the waste batch is characterized. When it has been verified that the waste meets the DBVS waste acceptance criteria the HIHTL connecting the waste staging tank and Tank 241-S-109 will be disconnected. The HIHTL from the DBVS facility will then be connected to the same connector on the waste staging tank. The contents of the waste staging tank will then be pumped to the DBVS receiver tank, via this HIHTL that will exit the farm, go under Cooper Avenue, and mate up with a receiver skid at the DBVS facility.

If analysis of tank contents determines that the waste batch is not acceptable for processing, it will be routed to the DST system.

4.2.2.2 Phase 2 Activities. During Phase 2, the “segmentation” concept from Phase 1 will no longer be required since the DBVS Facility will be a Hazard Category-2 facility. Waste transfer rates will be increased to an anticipated 76 L/min (20 gpm). The waste tank can, and will be, directly connected to the DBVS facility. The transfer route from Tank 241-S-109 to DBVS will bypass the waste staging tank skid. The solids/liquid separator and the sensing instrumentation will be retained but the solids/liquid separator capacity will be increased to accommodate the increased waste flow rate.

4.2.3 Waste Receipt and Storage

The WRS transfers waste into waste receipt tank(s) for process feed, storage, and sampling. The waste received will be stored in tanks as noted in Table 2-1. Tank capacities are based on anticipated waste processing rates described in Sections 1.7.5 and 4.2.1. All waste storage tanks will be double-wall construction with HIHTL and leak detection provisions. Waste tanks will be vented through the offgas treatment system (Sections 4.2.15 and 4.2.16).

A single 3,780-L (1,000-gal) waste receipt tank will be used during Phase 1 because the total amount of waste treated in the initial campaigns will be minimal. The use of a small tank will limit the amount of waste stored during Phase 1 to an amount below Hazard Category-3 requirements.

At the completion of Phase 1, the 3,780-L (1,000-gal) storage tank may be retained and used for storage of process additives such as simulated waste materials (simulants) or spiking agents during Phase 2 if allowed after flushing and inspection to clean debris standards.

Three Waste Receipt Tanks will be installed during Phase 1 for Phase 2 operations so that one or more tanks can be used to provide waste feed for treatment while the other tanks are being filled and sampled as described in Section 6.0. The waste receipt tanks have a maximum capacity of 68,137 liters (18,000 gallons) each and are constructed of carbon steel. Secondary containment is provided by a secondary tank that encloses the inner tank and will hold the entire contents of the primary tank. Leak detection is provided by a high level alarm located in the sump for each tank and will detect a leak at 65 gallons. The Waste Receipt System is represented on Process Flow Diagram B-4 located in Appendix B of Permit Attachment KK. P&IDs for the Waste Receipt System and the detailed designs are also located in Permit Attachment KK. The detailed design for the Waste Receipt Tanks is provided on drawings DBVS-SK-M105, sheets 1 and 2, F-145579-00-P-005, and Specification F-145579-D-SP-028.

4.2.4 Process Additives

The DBVS will use soil, waste simulants, glass additives, offgas treatment chemicals, and other materials as process additives. Table 4-1 contains a summary of these materials, their storage methods, and uses. Soil will be used to form the matrix for the vitrification process and to add an additional layer of clean material on the vitrified mass in the container. Waste simulants will be used for running system verification tests prior to treatment of actual SST waste during Phase 1 and as “filler” to attain the required process material volume (waste plus simulant) for a given test campaign during testing in both phases. Waste simulants could include spiking agents for specific process performance testing purposes. The majority, estimated at seventy-five percent (75%) of simulants will be used in Phase 1. A 68,140-L (18,000-gal) double-wall tank will be used for simulant storage during this phase. This tank may be retained onsite for use as one of the waste storage tanks for Phase 2 operations or may be removed from the site at the completion of Phase 1. Process additives will be kept in dedicated storage areas segregated from regulated waste storage to minimize the possibility of contamination. Residual simulant material not used in Phase 2 will be analyzed for dangerous waste characteristics and, if designated as dangerous waste, will be managed in accordance with standard Hanford Site procedures.

Graphite will be placed in the vitrification container to help initiate the soil/waste melting process. Boron and zirconium will be used in small quantities (approximately 2,100 kg (4,630 lbs) and 3,000 kg (6,615 lbs) per container load, respectively) to optimize glass performance. Sand will be used as an insulator.

4.2.5 Dry Material Handling

Clean soil is added to the dryer from the Process Additive Handling System through a penetration into the enclosure and a nozzle penetration into the dryer. The addition of zirconium oxide and boron oxide is accomplished through two connection points through the enclosure and then through the other dryer nozzles. Process additives are added to meet a target composition for the final dried waste product. Process additives (soil, xirconium oxide, and boron oxide) are gravity feed into the dryer. Addition of each material is controlled using a pair of spherical disk valves located beneath each of the three impingement tanks (See Attachment LL, Appendix 3, Section 3, Drawings F-145579-31-A-0100 and F-145579-31-A-0101). The loading point for soil into the treatment system will be equipped with parallel storage silos and a baghouse air pollution control system. For stockpiles, engineering controls for dust suppression will be implemented.

Table 4-1. Process Additives Information

Additive	Form	Storage Method	Use	Point of Introduction
Soil	Solid	Hopper (Phase 1) Hopper stockpile (Phase 2)	Vitrification matrix, container topoff	Dryer
Sand	Solid	Stockpile	Insulating material	ICV container
Waste simulants	Solid/slurry	Tank	Waste material substitute; “spiking agents”	Waste receipt tank, dryer
Graphite	Solid	Containers	Vitrification aid	ICV container
Boron	Solid	Containers	Glass performance aid	Dryer
Zirconium	Solid	Containers	Glass performance aid	Dryer
Water	Liquid	Tank	Air pollution control	Quench unit, venturi scrubber,
Ammonia	Gas	Pressurized tanker	Air pollution control	Selective catalytic reduction

4.2.6 Liquid Material Handling

Liquid materials other than waste feed will be used during DBVS operations. These include water and scrubbing chemicals. Water will be provided directly from tanker trucks. Other liquid material used will either be stored in portable tanks or in containers (e.g., carboys, drums) depending on the material handling requirements and/or the quantity used. Materials stored in portable tanks will be replenished either by removal and replacement of the tank or refilling from a tanker. Liquid chemical storage areas will be provided with suitable spill containment provisions.

4.2.7 Gaseous Material Handling

As an integral part of a best available control technology program, ammonia will be used as an air pollution control aid for removal of oxides of nitrogen (NO_x). The gas will be supplied from a pressurized liquid ammonia tanker truck. Ammonia will be vaporized and injected into the offgas stream to ensure proper mixing and efficient NO_x scrubbing.

4.2.8 Waste Feed Preparation

Before the vitrification process begins, the waste material will be mixed with additives and dried to remove moisture in a batch-mode rotary mixer/dryer. The 10,000-L mixer/dryer receives waste through nozzles located on top of the mixer/dryer (Permit Attachment LL, Appendix 3 Figure 143643-D-SP-001). Glass-forming additives are also added through nozzles on top of the dryer. Heat and vacuum are used to dewater the waste feed/soil mixture. The unit will be indirect-heated by steam from an onsite diesel-fired boiler. The boiler is a closed-loop system. The mixer/dryer mixes the contents with rotating plows that direct the waste from the ends of the mixer/dryer towards the center. The vacuum facilitates the dewatering process by promoting evaporation at a low temperature (140°F), and withdrawing the vapor from the mixer/dryer headspace.

Appropriate additives will be conveyed or transferred to the unit. Waste material will be pumped from waste receipt storage tanks. The dry material transfer systems will be equipped with weigh stations to control the amount of material being added to the dryer.

The mixer/dryer fill capacity for waste salt solution and process additives is 10,000 L (2,645 gal) at a nominal fill fraction of 45 to 50% (48.4% is the measured fraction from testing). The nominal drying cycle time is eight hours but may be as short as six hours for relatively dry incoming waste. During the mixing/drying cycle, the unit will be maintained under vacuum to promote the release of moisture from the material being processed at a reduced temperature. Off gas emission controls are described in Section 4.2.14. The moisture content of the material will be monitored by a load cell on the unit (noting the weight of moisture removed) and a moisture sensor in the exhaust duct. The Dried Waste Handling System will pneumatically convey dried waste from the mixer/dryer to the ICV System. The Dried Waste Handling System consists of the dried waste inlet skid, the dried waste transfer skid, the waste receiver and filter housings, the ancillary waste transfer enclosure (AWTE) and the interconnecting piping and valves. The waste receiver units also have sintered metal filters and HEPA filters for treatment of air exiting the waste receiving units. The detailed design for the Dried Waste Handling System is provided on drawings DBVS-SK-M107, sheets 1 through 3, in Permit Attachment LL, Appendix 5, Section 3, and F-145579-00-D-0041, F-145579-00-D-0051, F-145579-33-A-0101 and F-145579-33-A-0106 in Permit Attachment LL, Appendix 5, Section 3.

Mixer/dryer offgases will be treated to remove moisture before being routed to the main offgas treatment system for additional emission control.

4.2.9 Vitrification Container Preparation

The typical waste container for the vitrification process is expected to be a steel box approximately 3.0 m (10 ft) high, 2.4 m (8 ft) wide, and 7.3 m (24 ft) long. Containers will comply with the waste acceptance criteria for the receiving TSD unit (a permitted Hanford Site facility). Prior to waste distribution, the container will be lined with insulating board, sand, and a layer of castable refractory. The castable refractory will face the waste material. A layer of melt-initiating graphite and soil will be placed over the castable refractory in the bottom of the container. Appendix F in Permit Attachment FF contains additional information on the ICV container refractory. The container will also contain a port(s) for sampling the vitrified waste to obtain samples for analyses listed in Section 6.0.

A steel lid with attached electrodes will be sealed onto the container prior to waste deposition using bolted flanges and a refractory gasket. The lid contains several ports for waste material addition, electrode connections, venting, sampling, and introduction of post-vitrification materials. All connections will be mechanically sealed to the container lid. In addition, waste transfer connections will be equipped with shutoff valves to prevent spillage of material as the chute is attached to and removed from the port. To minimize potential contamination to workers and the environment, the connection points will be equipped with secondary containment and spilled material recovery equipment during material transfer, melting, and cooldown. Containment will consist of an ancillary waste transfer enclosure (AWTE) that seals to the container lid before waste is added to the container. The AWTE provides containment while the waste and soil addition connections are made and during the melt process. The operator is able to access the waste and soil addition connections in the AWTE. Once the melt is complete and the container is cool enough to add clean soil on the top, the AWTE will be removed to allow the container to move to the temporary storage area. The waste container filling/vitrification station will be equipped with shielding, as required. (Permit Attachment LL, Appendix 6, Section 3, Drawing # F-145579-35-A-0099.)

4.2.10 In-Container Vitrification

The waste mixture, including simulants and glass formers, from the mixer/dryer will be placed into the vitrification container through ports in the sealed container lid. Electric power will be applied to the electrodes, vitrifying the container contents via resistive heating to produce ILAW. The ILAW is the final RCRA waste form for disposal. Ambient air, filtered through a HEPA filter, is injected to assist in establishing and maintaining airflow through the container to the offgas treatment system, cool the vitrification offgases, and provide thermal protection for HEPA filters in the offgas treatment system. Vitrification offgases are vented under induced draft to the offgas treatment system. During the vitrification process, the depth of material will typically decrease due to consolidation in melting. (Permit Attachment LL, Appendix 6, Section 3, Drawing # F-145579-35-A-0100.)

Both “bottom-up” and “top-down” melting may be conducted during testing to determine the most effective method of waste treatment. The current plans focus on the bottom-up melt procedure; however, there may be a need to perform top-down melting at some time during the testing process. Top-down melting is conducted by applying power to the electrodes only after all waste materials and process additives have been placed in the container. Bottom-up melting begins melting with a shallow layer of material in the container and continues as more material is added until the desired depth of melt is obtained.

4.2.11 Post-Vitrification Activities

After vitrification has been completed, the container connection to the offgas treatment system will be maintained. Clean fill materials will be added to fill cavities around the electrodes and cover the top of the vitrified mass to minimize headspace in the container, creating a container that is at least 90% full.

Sampling of the vitrified waste, radiation surveying, and external decontamination (container wipedown, vacuuming of dust, etc.), as necessary, can be conducted any time after initial cooling has been completed. Sampling of the melt will be conducted by a coring process through a port in the side of the container. The method of sealing the sampling port during and after sampling has not been finalized. However, the port will be sealed in such a manner that the container remains in compliance with the RD&D Permit and the permitted storage/disposal facility waste acceptance criteria. Sampling protocol and methodology is addressed in Section 6.0. The data obtained will be used for waste form qualification, risk assessment, and performance assessment.

Temporary storage for up to 50 treated waste containers will be located at the north end of the Test and Demonstration Facility (Figure 2-2). At the completion of RD&D activities, the containers will be transported to the IDF or to another permitted Hanford Site storage/disposal facility.

4.2.12 Offgas Treatment Requirements

Emissions may consist of either fugitive (i.e., bulk process additive loading and transfer) or point (i.e., stack) sources. Hazardous or radioactive emissions will not be released through fugitive sources, as those sources will be limited to nonhazardous and nonradioactive materials. Emission calculations for all sources will utilize appropriate emission factors, source classification codes, or other information. Fugitive emissions, which will consist only of nonhazardous materials such as dust from process additive transfers, will be addressed in the *New Source Review Notification of Construction for the Supplemental Treatment Test and Demonstration Facility (*Schepens 2004*)*.

Point sources may emit both nonradioactive and radioactive emissions. These sources will be equipped with a continuous emissions monitoring system (CEMS) that will monitor and record emissions of radionuclides (beta and gamma detectors) and those criteria pollutants (e.g., particulate matter, carbon monoxide [CO], NO_x, and oxides of sulfur [SO_x]) for which regulatory monitoring requirements exist and are included in the final emission source permit(s)). The CEMS will be designed, installed, and operated in compliance with applicable portions of 40 CFR 60, Appendix B. The design of the gaseous and particulate effluent monitoring system will comply with ANSI/HPS N13.1, *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities.* The CEMS data will be acquired in real time, but will be available for review in the form of periodically generated reports. Offgas treatment for DBVS operations will address the following issues:

- Particulate and gaseous emissions from waste receipt and storage
- Particulate emissions from process additive receipt, storage, and transfer (not including fugitive emissions from stockpiles)
- Particulate and gaseous emissions from mixer/dryer (dedicated partial system)
- Particulate and gaseous emissions from waste container filling and vitrification
- Particulate emissions from waste container topoff after vitrification.

All offgas treatment system connections to treatment equipment and the waste container tops will be sealed and the offgas ducting maintained under induced draft to prevent escape of pollutants.

With the exception of process additive management emissions, all emissions will be routed to an offgas treatment system prior to discharge to the atmosphere. Nominal efficiencies and the major pollutant controlled by the various offgas treatment system components used are provided in Table 4-2. Table 4-3 contains calculated removal efficiencies for major pollutants. Removal efficiencies were calculated using the Table 4-2 component efficiencies and the offgas treatment system arrangement in Appendix B. Appendix B contains additional information on the offgas treatment system components and efficiencies.

Table 4-2. Offgas Treatment Component Efficiencies

Component	Nominal Control Efficiency					
	Water/ Water Vapor	Organic Compounds	HCl	NO_x	SO_x	Particulate[1]
Baghouse	—	—	—	—	—	99%
Condenser	95 – 98%	70%	<10%	<10%	<10%	—
Mist Eliminator	10 – 25%	—	—	—	—	—
Sintered Metal Filter	—	—	—	—	—	99.5%
HEPA Filter	—	—	—	—	—	99.95%
Packed Tower Quencher	—	70%	93%	93%	93%	<50%
Venturi Scrubber	—	71%	25%	25%	25%	95%
Selective Catalytic Reduction Unit(s)	—	50%	—	97.3%[3]	—	——
Carbon Filter[2]	—	95 – 99%	25%	25%	25%	—

[1] Particulate removal efficiencies are for ten-micron (10 μ) particle diameters and up. Removal efficiencies are based on AP-42 (EPA 1995), Appendix B.1, reference texts and process knowledge

[2] Efficiency range varies with pollutant adsorbed

[3] The selective catalytic reduction design goal is 99% efficiency

4.2.13 Process Additive Emissions Control

Particulate emissions from offloading and transfer of process additives will be controlled by dedicated baghouse and vent systems. A covered hopper with a sealed pneumatic conveying system will be used to transfer soil to the mixer/dryer soil holding tank or silos. Particulate matter collected at the baghouses is returned to the appropriate additive storage area for reuse.

4.2.14 Mixer/Dryer Offgas Emissions Control

The mixer/dryer emissions will be partially treated for moisture removal using a glycol-cooled condenser prior to being routed to the main offgas treatment system. As the vapor is produced in the dryer, it is pulled by the vacuum pump through a sintered metal filter to remove particulates before the vapor reaches the condenser unit. The particulates captured in the filter are returned to the dryer drum via back-pulsing the filters with compressed air. Condensable gases are captured in the Condensate Recovery System by a condenser unit cooled by the dryer chiller pump skid and chiller unit. Condensate is collected in Tank 33-D74-015 (Permit Attachment KK, Appendix 3, Section 3, Figure F-145579-33-A-0101). The partially treated offgases from this system will then be routed to the main offgas treatment system downstream of the chemical/venturi scrubber. In the event that the dryer offgas system is not operating, the gases in the waste dryer will flow through a rupture disk (Set to rupture at 5 psig and 250°F) to the main offgas treatment system. (Permit Attachment LL, Appendix 7, Section 3, Figure F-145579-36-A-0102.) Water condensed in the condenser and removed in the mist eliminator will be routed to the Secondary Waste System for sampling and subsequent treatment or disposal. Estimated rates and volumes of liquid secondary wastes generated from offgas emissions control system operations are provided in Section 2.6.

Table 4-3. Pollutant Removal Efficiencies[1]

Pollutant	Nominal Control Efficiency
Moisture	96%
Organic Compounds	98%
HCl	55%
NO_x	99.95%
SO_x	<50%
Particulate Matter	>99.9999%

[1] Based on arrangement of offgas treatment system components in Appendix B process flow diagrams

4.2.15 Phase 1 Main Offgas Treatment System

The Phase 1 offgas treatment system will consist of two stages of sintered metal particulate filters, a glycol-cooled condenser, a quench section, one atomizing chemical scrubber/venturi scrubber, mist eliminator system, additional stages of HEPA filtration and an independent NO_x treatment device.

Offgas from the melting process first passes through two stages of sintered metal particulate filtration. The purpose of the filters is to minimize radioactive contamination of downstream components to facilitate maintenance and operations. Dust collected from the sintered metal filters is recycled to the mixer/dryer. Dust from the final batch will be incorporated into the mixer/dryer where a final container using clean fill material will be processed to flush the system, and sent to the IDF or another permitted disposal facility. See Permit Attachment LL, Appendix 7, Section 3, Figure F-145579-36-A-0099 for details. HEPA filters later in the system backup the sintered metal filters ensuring the particulate emissions are minimized.

After the sintered melt filters, the offgas passes through a quencher that cools the gas prior to introduction into the atomizing chemical scrubber/venturi scrubber. In addition to quenching the offgas, the quencher augments the ability of the system to remove particulate matter and gaseous pollutants, and it provides additional redundancy or capability to the offgas system. (Permit Attachment LL, Appendix 7, Section 3, Figure F-145579-36-A-0100.)

Following the quencher, offgas is introduced into an atomizing chemical venturi scrubber. Dilute sodium hydroxide will be injected in the atomizing scrubber section to reduce hydrogen chloride and other acid gas emissions. In addition to scrubbing hydrogen chloride and other acid gas emissions from the offgas, the scrubber augments the ability of the system to remove particles and NO_x.

Following the atomizing chemical venturi scrubber, offgases will pass through an additional condenser and a mist eliminator, with drainage from this unit routed to the scrubber recycle tanks. Condensed liquids are drained into the scrubber recycle tank. An offgas heater, parallel HEPA filters, and a carbon filter for radioactive iodine removal will follow the mist eliminator. (Permit Attachment LL, Appendix 7, Section 3, Figures F-145579-36-A-0102 and F-145579-36-A-0107.)

NO_x treatment will be accomplished by a selective catalytic reduction (SCR) unit. Offgases will be discharged through redundant exhaust blowers in parallel, and the system stack. (Permit Attachment LL, Appendix 7, Section 3, Figure F-145579-36-A-0103.)

Venturi scrubber blowdown contaminant types and their weight fractions/concentrations are provided in Table 4-4. Carbon filters will be modular units rather than refillable contactors. Upon reaching saturation, the units will be removed, sampled, and disposed.

Table 4-4. Scrubber Blowdown Contaminants

Contaminant	Concentration
Sodium Hydroxide (NaOH)	2 % by weight
Sodium Nitrate ($NaNO_3$)	13 % by weight
Sodium Carbonate (Na_2CO_3)	2.5 % by weight
Sodium Sulfite (Na_2SO_3)	0.5 % by weight
Sodium Chloride (NaCl)	0.02% by weight
Sodium Fluoride (NaF)	4 ppm by volume
Cs-137	Trace

The emergency bypass is designed for emergency use and will only be used when the OGTS has an unexpected shutdown, due to power loss or major equipment failure. Should this happen automatic interlocks will stop the glassforming process by ceasing the melt feed and removing power from the ICV box electrodes. The same interlocks cause the Main OGTS to be bypassed and direct remaining off-gas generated after the process shutdown through the emergency bypass to discharge through the 155-ft stack. This shutdown process is designed to meet the permit requirements stated in Part II, Section II.A.5.

To minimize emergency bypass usage the OGTS has been designed to be a very reliable system with redundant equipment at key potential failure points (HEPAs, HEGAs, Exhaust Fans, etc.). For example, the SMFs, although normally operated in sequence, are capable of being bypassed so that each can run while bypassing the other. The number of controls valves has also been minimized to improve reliability. The design includes sufficient sensors and data collection to accurately track all emergency bypass events and event duration that lead to use of the emergency by-pass. The design of the system meets UBC seismic and code requirements, resulting in enhanced quality specifications. Note: As used within this text, any reference to the OGTS bypass implies OGTS emergency bypass.

4.2.16 Phase 2 Main Offgas Treatment System

It is not expected that any enhancements of the offgas treatment system will be required between the end of Phase 1 and the beginning of Phase 2. However, if the Phase 1 offgas treatment system performance does not meet expectations, changes to the system will be made with prior Ecology approval.

4.2.17 Control and Data Acquisition System

The DBVS control system and the associated data acquisition systems will be located in a trailer as shown in Figure 2-2. Some operating parameters may be monitored and operating steps may be performed manually as opposed to remotely. Personnel safety and ALARA considerations will require that many of the operations directly related to the process (mixer-dryer, melt station) be monitored and performed remotely. Other operations such as operation of the utilities, secondary waste, SCR, etc, will have key parameters monitored remotely while other monitoring and operating steps are manual. Both RD&D experiment data (process operating conditions) and offgas emissions data will be acquired.

4.3 SECONDARY WASTE STREAMS

4.3.1 General

All Test and Demonstration Facility secondary waste streams (i.e., any output stream other than the treated DBVS waste) will be managed in accordance with the appropriate Hanford Site receiving TSD unit waste acceptance criteria for the treatment and/or disposal path for each stream. A waste minimization program for secondary wastes will be implemented. Shipments of waste to offsite treatment or disposal facilities are not anticipated. However, should they occur, these shipments will be conducted in compliance with WAC 173-303-280(1).

Nonradioactive nonhazardous waste streams include air pollution control equipment dusts from process additive transfer, used baghouse filters, empty process additive containers, and damaged/failed equipment. These waste materials will be managed as general solid waste per *Hanford Environmental Protection Requirements*, and will meet the appropriate waste receiving units waste acceptance criteria.

4.3.2 Liquid Effluent Secondary Waste Streams

The Test and Demonstration Facility will produce the liquid secondary wastes noted in Table 4-5. The secondary waste stream will be sampled and analyzed prior to being routed to the ETF or other facility for treatment. Sampling and analysis will be performed in accordance with the waste acceptance criteria of the receiving disposal facility. Secondary wastes will be collected either continuously or at scheduled intervals and stored at the Test and Demonstration Facility in 68,140-L (18,000-gal) double-wall tanks. Up to 10 liquid effluent storage tanks may be onsite at the Test and Demonstration Facility at a given time, depending on the rate of waste generation and the duration of sampling and analysis. Sampling and analysis procedures are noted in Section 6.0. When a tank is filled, its contents will be sampled and the waste will be transported to the ETF. If required, wastes will be filtered prior to shipment to ETF. If the waste does not meet ETF waste acceptance criteria, it will be sent to a DST or other approved Hanford Site storage facilities.

The Secondary Waste System is located on the northwest corner of the DBVS site (See drawings F-145579-00-D-0002, F-145579-00-P-0008 and F-145579-00-P-0013 in Attachment KK, Appendix 4, Section 3). The secondary waste storage tanks and ETF tanker loadout station are located north of the OGTS fan/Stack assembly. Tank construction will meet the requirements of WAC 173-303-640 and will be equipped with freeze protection consistent with Performance Category-2 (ambient temperature of 34°C [30°F]). The secondary waste pump skid is located just south of the secondary waste storage tanks and east of the OGTS Stack and fan assembly. The loadout station is depicted on P&ID F-145579-37-A-0100 located in Attachment KK, Appendix 4, Section 3. The spill confinement berm for the tanker truck is designed specifically for the purpose of confining spills that might occur during tanker loading operation. The loadout station is depicted on P&ID F-145579-37-A-0100 located in Attachment KK, Appendix 4, Section 3.

Table 4-5. Liquid Secondary Wastes

Waste	Source	Frequency of Generation	Pollutants
Washdown Water	Equipment Cleaning, Spill Remediation	Recurring (Equipment Cleaning) Infrequent (Spill Remediation)	Particulate Matter, Radionuclides, Caustic (high pH) Solution
Boiler Blowdown	Boiler Maintenance	Infrequent	Particulate Matter, Boiler Antifouling Agents, Surfactants
Mixer/Dryer Condensate,	Mixer/Dryer Offgas Condenser, Mist Eliminator Operation	Recurring (Scheduled Holding Tank Discharge)	, Radionuclides
Scrubber System Blowdown or Bleed	Main Offgas Treatment System Operation	Recurring (Scheduled Scrubber Holding Tank Blowdown) Continuous (Scrubber Holding Tank Bleed)	Particulate Matter, Radionuclides, Caustic (high pH) Solution, Dissolved Inorganic Gases, Dissolved Acid Gases, Organic Compounds

4.3.3 Solid/Semisolid Secondary Waste Streams

The Test and Demonstration Facility will produce the solid, semisolid, or sludge secondary wastes noted in Table 4-6. Unless otherwise stated, these wastes will be collected on a scheduled basis and disposed in permitted facilities. Wastes that will routinely be returned to process use, such as spilled nonhazardous process additives, are not included in this list.

Table 4-6. Solid/Semisolid Secondary Wastes

Waste	Source	Frequency of Generation	Pollutants
Spent Carbon Filters	Main Offgas Treatment System	Scheduled or Upon Detection of Pollutant Breakthrough	Particulate Matter, Radionuclides, Organic Compounds
Spent HEPA Filters	Mixer/Dryer Offgas Treatment System, Main Offgas Treatment System, ICV® Purge Air Inlet	Scheduled	Particulate Matter, Radionuclides, Organic Compounds
Spent SCR Catalyst	Main Offgas Treatment System	Scheduled or Upon Detection of Catalyst Fouling/Poisoning	Particulate Matter, Radionuclides, Organic Compounds
Scrubber Tank Sludge	Main Offgas Treatment System	Scheduled or Upon Detection of Excessive Buildup	Inorganic Solids, Water Containing High or Low pH Inorganic Compounds, Radionuclides, Caustic (high pH) Solution, Organic Compounds
Used Personal Protective Equipment	Equipment Cleanup, Maintenance, and Operation	Recurring	Particulate Matter, Radionuclides
Failed/Damaged Equipment	Equipment Cleanup, Maintenance, and Operation	Recurring	Particulate Matter, Radionuclides